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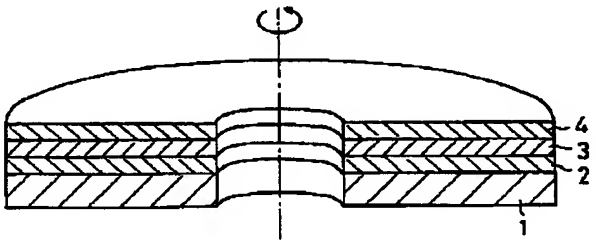
(54)【発明の名称】　垂直磁気記録媒体

(57)【要約】

【目的】　本発明は、記録再生時の感度と分解能の劣化を招くことなく、パルクハウゼンノイズを抑制することができる垂直磁気記録媒体を提供することを目的とする。

【構成】　本発明の垂直磁気記録媒体は、基板上にバイアス磁界付与膜、高透磁率磁性膜、垂直磁化膜を順次形成して構成される。



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【特許請求の範囲】

【請求項1】　基板と、この基板上に形成された高透磁率磁性膜と、この高透磁率磁性膜上に形成された信号磁化を記録する垂直磁化膜とからなる垂直磁気記録媒体において、少なくとも前記高透磁率磁性膜の基板側の面にバイアス磁界付与膜を形成したことを特徴とする垂直磁気記録媒体。

【請求項2】　前記バイアス磁界付与膜と前記高透磁率磁性膜との間に非磁性膜を形成してなることを特徴とする請求項1記載の垂直磁気記録媒体。

【請求項3】　前記バイアス磁界付与膜は、反強磁性膜であることを特徴とする請求項1又は請求項2記載の垂直磁気記録媒体。

【請求項4】　前記バイアス磁界付与膜は、面内配向性を有する高抗磁力磁性膜であることを特徴とする請求項1又は請求項2記載の垂直磁気記録媒体。

【請求項5】　前記バイアス磁界付与膜は、磁性膜と非磁性膜とが交互に積層された少なくとも2つの前記磁性膜からなる積層膜であって、前記非磁性膜を介して積層された相対向する前記磁性膜が反強磁性的に結合してなることを特徴とする請求項1又は請求項2記載の垂直磁気記録媒体。

【請求項6】　基板と、この基板上に形成された高透磁率磁性膜と、この高透磁率磁性膜上に形成された信号磁化を記録する垂直磁化膜からなる垂直磁気記録媒体であって、前記垂直磁化膜における記録再生領域の両端の所定領域を相対する方向に垂直磁化することを特徴とする垂直磁気記録媒体。

【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明は、磁気ディスクやVTR等に使用される垂直磁気記録方式の磁気記録媒体に関するものである。

【0002】

【従来の技術】垂直磁気記録方式に使用される垂直磁気記録媒体としては、基板から離れた側に媒体面垂直方向を磁化容易軸とする垂直磁化膜を形成し、基板から近い側に高透磁率磁性膜を形成した2層構造の記録媒体があり（特開昭52－78403号公報）、この2層構造垂直磁気記録媒体は、垂直磁化膜が単層の記録媒体よりも優れた記録再生特性を示すことが知られている。

【0003】しかしながら、上記従来の2層構造垂直磁気記録媒体においては、記録再生時にスパイク状のノイズが観測される。このスパイク状ノイズは、垂直磁化膜のみからなる単層構造の記録媒体を用いて記録再生実験を行う際には観測されないことが確認されており、従って、高透磁率磁性膜とその上に積層された垂直磁化膜との相互作用により生じるものではなく、高透磁率磁性膜のみから生じるものである。また、このスパイク状ノイズは、媒体中で一様に発生するものではなく、発生する

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領域と発生しない領域があり、スパイク状ノイズが発生する領域では磁壁が多く発生しており、スパイク状ノイズが発生しない領域では磁壁は発生しない。このスパイク状ノイズは、磁壁が不可逆的な遷移をすることに起因するもので、一般にバルクハウゼンノイズと呼ばれている。

【0004】以上のことから、バルクハウゼンノイズの発生を抑制するためには、高透磁率磁性膜中の磁壁の発生を抑制すれば良いことがわかる。このバルクハウゼンノイズの発生を効果的に抑制するものとして、強磁性体と反強磁性体の界面に生じる交換結合を利用することによって、反強磁性膜が高透磁率磁性膜へのバイアス磁界を印加し、その結果、高透磁率磁性膜中の磁壁の発生を抑制するという方法が知られている（特公平3－536866号公報）。この垂直磁気記録媒体の構造は、基板上にまず高透磁率磁性膜を形成し、この高透磁率磁性膜の上に反強磁性膜を形成し、さらにこの反強磁性膜の上に垂直磁化膜を形成したものである。このように形成された垂直磁気記録媒体の記録再生時においては、確かにバルクハウゼンノイズが抑制されることが示されている。

【0005】しかしながら、この上述の構造は、垂直磁化膜と高透磁率磁性膜との間に反強磁性膜を形成するため、反強磁性膜の厚みが記録再生時にスペーシング損失として働き、その結果、記録再生効率と記録分解能の低下をもたらし、バルクハウゼンノイズは抑制することができるものの、記録再生時における感度及び分解能が十分でないという問題があった。

【0006】

【発明が解決しようとする課題】上述の如く、基板上に高透磁率磁性膜、高透磁率磁性膜、反強磁性膜、反強磁性膜及び垂直磁化膜を順次形成した垂直磁気記録媒体における記録再生時においては、バルクハウゼンノイズが抑制される反面、垂直磁化膜と高透磁率磁性膜との間に反強磁性膜を形成するため、反強磁性膜の厚みが記録再生時にスペーシング損失として働き、その結果、記録再生効率と記録分解能の低下をもたらし、バルクハウゼンノイズは抑制することができるものの、記録再生時における感度及び分解能が十分でないという問題があった。

【0007】本発明は、バルクハウゼンノイズを抑制することができると共に、しかも高感度で、かつ、高分解能の記録再生を可能とする垂直磁気記録媒体を提供するものである。

【0008】

【課題を解決するための手段】本発明は上記従来の課題を解決するために、基板と、この基板上に形成されたバイアス磁界付与膜と、このバイアス磁界付与膜上に形成された高透磁率磁性膜と、この高透磁率磁性膜上に形成された信号磁化を記録する垂直磁化膜とから構成する。

【0009】

【作用】本発明によれば、基板上にバイアス膜、高透磁

率磁性膜及び垂直磁化膜を順次形成してなるので、バイアス膜と高透磁率磁性膜との界面には交換相互作用が働き、この高透磁率磁性膜にはバイアス磁界が印加され、その結果、高透磁率磁性膜中の磁壁発生が抑制されてバルクハウゼンノイズを抑制することができる。

【００１０】また、基板上に高透磁率磁性膜、垂直磁化膜を順次形成し、垂直磁化膜のトラック幅方向の両端の領域を互いに逆方向に垂直磁化することによって、該領域は高透磁率磁性膜と磁気的に結合され、垂直磁化された領域に対応する高透磁率磁性膜中の磁化を磁気ディスクのトラック幅方向（ディスク半径方向）に固着して動きにくくすると、垂直磁化膜における垂直磁化領域の間の記録再生領域４ｃの位置に対応する高透磁率磁性膜中には、トラック幅方向にバイアス磁界が印加され、高透磁率磁性膜３内の磁壁の発生を抑制することができ、バルクハウゼンノイズの発生を抑制することができると共に、垂直磁化膜の記録再生領域の位置に対応する高透磁率磁性膜の領域におけるトラック長手方向（ディスク円周方向）の透磁率は、ほとんど低下することがないので記録再生効率の低下を招くことがない。

【００１１】さらに、垂直磁化膜と高透磁率磁性膜との間にスペーシング層が存在しないので、記録再生時のスペーシング損失がなく、高記録再生効率で、かつ、高分解能を得ることができる。

【００１２】

【実施例】以下、図面を参照しながら本発明の一実施例について説明する。

【００１３】図１は、本発明の第１実施例に係る垂直磁気記録媒体の構成を示す縦断面図である。この垂直磁気記録媒体は、アルミ、ガラス等の円環板状のディスクからなる基板１上にＦｅＭｎ、ＮｉＯ等の反強磁性膜からなるバイアス磁界付与膜２が形成され、このバイアス磁界付与膜２上にパーマロイ、Ｆｅ基軟磁性膜、或いはＺｒ系のアモルファス軟磁性膜等からなる高透磁率磁性膜３が形成されている。さらに、高透磁率磁性膜３上には、信号磁化が記録されるＣｏＣｒ、ＣｏＰｔ等からなる垂直磁化膜４が形成されてなっている。

【００１４】バイアス磁界付与膜２は、反強磁性膜の代わりにＣｏＰｔ、ＣｏＰｔＣｒ、ＣｏＣｒ等の高抗磁力磁性膜であっても構わない。また、バイアス磁界付与膜２は、図２に示すように、磁性膜２１と非磁性膜２２とが交互に積層され、非磁性膜２２を介して積層された相対向する磁性膜２１，２１が反強磁性的に結合した人工格子膜であっても構わない。この人工格子膜は、例えば、ｎ層からなる（ＣｏＦｅ／Ｃｕ）ｎ、（Ｃｏ／Ｃｕ）ｎ、（Ｆｅ／Ｃｒ）ｎ等が挙げられる。

【００１５】以上のような構成にすることにより、バイアス磁界付与膜２と高透磁率磁性膜３とは、その界面において交換結合し、高透磁率磁性膜３にバイアス磁界が印加されるため、高透磁率磁性膜３内での磁壁の発生が抑制され、スパイク上のバルクハウゼンノイズの発生を抑制することができる。また、垂直磁化膜４は、高透磁率磁性膜３上に直接形成されるため、記録再生時におけるスペーシング損失がなく、高分解能で、かつ、高い記録再生効率を得ることが可能となる。

【００１６】なお、本実施例におけるバイアス磁界付与膜２及び高透磁率磁性膜３をスパッタ法等によって成膜する際には、磁気記録媒体の記録トラック幅方向に磁界を加えながら誘導磁気異方性を付与すれば、高透磁率磁性膜３に対して効果的にバイアス磁界を印加することができるようになる。

【００１７】図３は、本発明の第２実施例に係る垂直磁気記録媒体の構成を示す縦断面図である。図３において、基板１上に形成されたバイアス磁界付与膜２と高透磁率磁性膜３との間には、非磁性膜５が設けられている。バイアス磁界付与膜２の種類によって、高透磁率磁性膜３との界面における交換結合の強度が異なるため、高透磁率磁性膜３に加わるバイアス磁界の強度も異なることになる。従って、交換結合が強すぎると高透磁率磁性膜３に対して必要以上のバイアス磁界が加わるため、高透磁率磁性膜３の透磁率μが減少して記録再生効率の劣化を招いてしまう。そこで、非磁性膜５をバイアス磁界付与膜２と高透磁率磁性膜３との間に設けることによって、交換結合の強度を調節することができ、最適な記録再生感度を維持しながらバルクハウゼンノイズを抑制することが可能となる。この非磁性膜５は、バイアス磁界付与膜２及び高透磁率磁性膜３の磁気特性や膜厚等の諸条件に応じてその種類や膜厚を選択すれば良い。

【００１８】図４は、本発明の第３実施例に係る垂直磁気記録媒体の構成を示す縦断面図である。図４においては、円環板状の磁気ディスクにおける最内周トラック４１と最外周トラック４１'との間の記録再生領域の外側の対応する所定位置に環状にバイアス磁界付与膜２が形成されている。この垂直磁気記録媒体は、以下に示す方法により製造される。すなわち、まず、図５（ａ）に示すように、基板１上にバイアス磁界付与膜を蒸着、スパッタ法等により成膜する。次に、図５（ｂ）に示すように、バイアス磁界付与膜２上にレジスト５１を塗布し、磁気記録媒体の記録再生領域となるべき領域（例えば、磁気ディスクの最内周トラックから最外周トラックを含む領域）をマスク５２によってマスクした後、感光させる。次に図５（ｃ）に示すように、マスク５２によって感光しなかった領域をエッチング等により取り除き、図５（ｄ）に示すように、レジスト５１を取り除いた後で、高透磁率磁性膜３及び垂直磁化膜４を蒸着、スパッタ法等により成膜する。

【００１９】従って、以上のような構成にすると、バイアス磁界付与膜２に相対向する高透磁率磁性膜３の部分にのみバイアス磁界が加わるため、この部分の磁壁の発生は抑制される。そして、この部分の磁壁発生の抑制

は、結果として、バイアス磁界が形成されていない領域まで効果的に磁壁の発生を抑制する。そのため、磁壁発生によるバルクハウゼンノイズを抑制することができる。

【００２０】なお、バイアス磁界付与膜２上における高透磁率磁性膜３の領域は、その領域に対応する垂直磁化膜４において信号磁化の記録再生が行われず、透磁率μを考慮する必要がないので、バイアス磁界付与膜２と高透磁率磁性膜３との交換結合強度を強くしても良い。また、本実施例においては、記録再生領域における透磁率μの低下がないので、磁気ヘッドとの磁気的相互作用を強くすることができ、さらに高感度、かつ、高分解能の記録再生を実現することが可能となる。

【００２１】さらに、本発明に係る垂直磁気記録媒体は、図６に示すように、高透磁率磁性膜３と垂直磁化膜４との間にも、反強磁性膜２’を設けるようにしても良い。この場合には、反強磁性膜２’は、スペーシング損失を作用させない程度に、薄く形成するようにする。

【００２２】図７は、本発明の第４実施例に係る垂直磁気記録媒体の構成を示す縦断面図である。本実施例に係る垂直磁気記録媒体は、基板１上に高透磁率磁性膜２、垂直磁化膜３が順に形成されている。また、円環板状の磁気ディスクにおける垂直磁化膜４の内周側及び外周側には、所定幅の垂直磁化領域４ａ，４ｂが形成されている。この垂直磁化領域４ａ，４ｂは互いに逆方向に、例えば、内周側の垂直磁化領域４ａは基板からヘッドに対向する面方向に、外周側の垂直磁化領域４ｂはヘッドに対向する面から基板方向に、垂直磁化されている。

【００２３】従って、この垂直磁化領域４ａ，４ｂと高透磁率磁性膜３とを磁気的に結合（交換相互作用による交換結合又は静磁結合のいずれでも良い）させることによって、垂直磁化領域４ａ，４ｂに対応する高透磁率磁性膜３中の磁化を磁気ディスクのトラック幅方向（ディスク半径方向）に固着して動きにくくすると、垂直磁化膜４における垂直磁化領域４ａ，４ｂの間の記録再生領域４ｃの位置に対応する高透磁率磁性膜３中には、破線７１で示すバイアス磁界が印加され、高透磁率磁性膜３内の磁壁の発生を抑制することができるので、バルクハウゼンノイズの発生を抑制することができる。また、垂直磁化膜４の記録再生領域４ｃの位置に対応する高透磁率磁性膜３の領域におけるトラック長手方向（ディスク円周方向）の透磁率は、ほとんど低下することがないので記録再生効率の低下を招くことがない。さらに、高透磁率磁性膜３と垂直磁化膜４との間に反強磁性膜等のスペーシング層を形成しないため、高い記録再生効率で、かつ、高分解能の垂直磁気記録媒体を実現することができる。

【００２４】図８乃至図１３に、本発明に係る垂直磁気記録媒体のその他の変形例を示す。図８における垂直磁気記録媒体は、高透磁率磁性膜３と垂直磁化膜４との間に非磁性膜５を形成したものである。すなわち、高透磁率磁性膜３と垂直磁化膜４との界面において、垂直磁化膜４の記録再生領域４ｃに対応する位置にその界面における交換結合を断ち切ることができる程度の非磁性膜５が形成されている。

【００２５】従って、高透磁率磁性膜３と垂直磁化膜４との記録再生領域４ｃに対応する界面においては静磁的に結合できるので、高透磁率磁性膜３を必要に応じて薄くした場合にも、高透磁率磁性膜３は信号磁化によって低下することなく良好な記録再生を実現することができる。

【００２６】図９における垂直磁気記録媒体は、基板１上に高透磁率磁性膜３、垂直磁化膜４が形成されている。そして、円環板状の磁気ディスクにおける垂直磁化膜４の内周側及び外周側には、トラック幅方向に磁化された長手方向に配向性を有する高抗磁力磁性膜６ａ，６ｂが所定幅で形成されているので、高透磁率磁性膜３と高抗磁力磁性膜６ａ，６ｂとを磁気的に結合することができ、同様の効果が得ることができる。

【００２７】図１０における垂直磁気記録媒体は、基板１上の内周側及び外周側には、トラック幅方向に磁化された長手方向に配向性を有する高抗磁力磁性膜６ａ，６ｂが形成され、この高抗磁力磁性膜６ａ，６ｂの間の記録再生領域に対応する位置に高透磁率磁性膜３が形成されている。さらに、この高透磁率３及び高抗磁力磁性膜６ａ，６ｂ上には信号磁化が記録再生される垂直磁化膜４が形成されている。この場合においても、高抗磁力磁性膜６ａ，６ｂの同一方向の磁化によって高透磁率磁性膜３に破線１０１の方向にバイアス磁界を印加することができ、同様の効果を得ることができる。

【００２８】図１１における垂直磁気記録媒体は、基板１上に第２の高透磁率磁性膜３’、非磁性膜５、この非磁性膜５上に高抗磁力磁性膜６ａ，６ｂ及び第１の高透磁率磁性膜３が順次形成され、さらにこれら高抗磁力磁性膜６ａ，６ｂ及び第１の高透磁率磁性膜３上に垂直磁化膜４が形成されてなっている。従って、高抗磁力磁性膜６ａ，６ｂと高透磁率磁性膜３’とを静磁結合させた場合には、高抗磁力磁性膜６ａ→高透磁率磁性膜３→高抗磁力磁性膜６ｂ→高透磁率磁性膜３’（或いはその逆）の経路を有する磁気回路抵抗の小さな閉磁路（破線１１１）が構成され、図９に示す垂直磁気記録媒体よりも強くて有効なバイアス磁界を印加することができるようになる。

【００２９】図１２における垂直磁気記録媒体は、基板１上に高抗磁力磁性膜６、非磁性膜５、高透磁力磁性膜３、垂直磁化膜４が順次形成されてなっている。そして、高抗磁力磁性膜６と高透磁率磁性膜３とは静磁的に結合されているので、高透磁率磁性膜３にはトラック幅方向にバイアス磁界が印加されることになる。

【００３０】図１３における垂直磁気記録媒体は、基板

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1上に高透磁率磁性膜3、垂直磁化膜4が順次形成され、記録再生領域の両端の位置に互いに反対方向の媒体面垂直方向に磁化された永久磁石7a，7bが設けられている。従って、上述の例と同様に高透磁率磁性膜3内にトラック幅方向のバイアス磁界を印加することができる。なお、永久磁石7a，7bの代わりに高抗磁力磁性膜6a，6bを用いても良い。

【0031】なお、本発明においては、いずれも磁気ディスク等の円板状の一方の面にのみ信号磁化が記録させるべき垂直磁化膜を形成したが、これにこだわることはなく、他方の面にも形成しても構わない。また、いずれも磁気ディスク等の円板状の垂直磁気記録媒体の例を示したが、磁気テープ等のテープ状の垂直磁気記録媒体に適用することもできる。

【0032】

【発明の効果】以上の通り本発明によれば、高透磁率磁性膜中の磁壁の発生を抑制することができ、高透磁率磁性膜と垂直磁化膜との界面に生じるバルクハウゼンノイズを効果的に抑制することができる。また、垂直磁化膜と高透磁率磁性膜との間には、反強磁性膜等のスペーシング層を形成しないため、反強磁性膜の厚みが記録再生時にスペーシング損失として働くことがなく、その結果として、高い記録再生効率で、かつ、高分解能の垂直磁気記録媒体を実現することができる。

【図面の簡単な説明】

【図1】　本発明の第1実施例に係る垂直磁気記録媒体の構成を示す図。

【図2】　図1におけるバイアス磁界付与膜の一例を示す図。

【図3】　本発明の第2実施例に係る垂直磁気記録媒体の構成を示す図。

【図4】　本発明の第3実施例に係る垂直磁気記録媒体の構成を示す図。

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【図5】　図4における垂直磁気記録媒体の製造工程を示す図。

【図6】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【図7】　本発明の第4実施例に係る垂直磁気記録媒体の構成を示す図。

【図8】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【図9】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【図10】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【図11】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

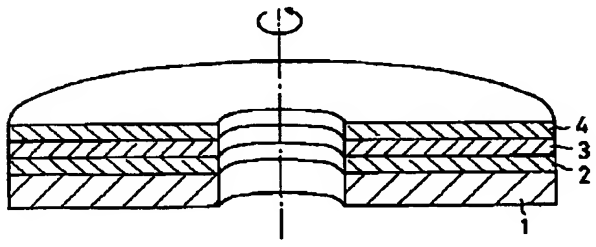
【図12】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【図13】　本発明に係る垂直磁気記録媒体の構成の変形例を示す図。

【符号の説明】

1　基板
2　バイアス磁界付与膜
3　高透磁率磁性膜
4　垂直磁化膜
5　非磁性膜
6a，6b　高抗磁力磁性膜
7a，7b　永久磁石
21　磁性膜
22　非磁性膜
41　最内周トラック
41'　最外周トラック
51　レジスト
52　マスク

【図1】



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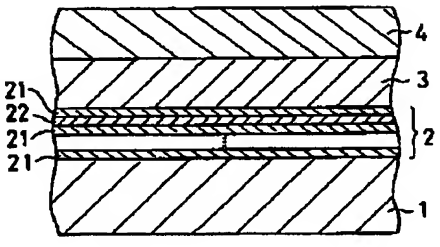

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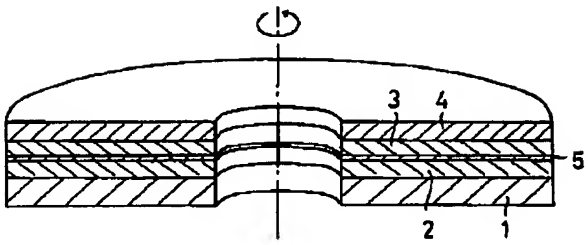

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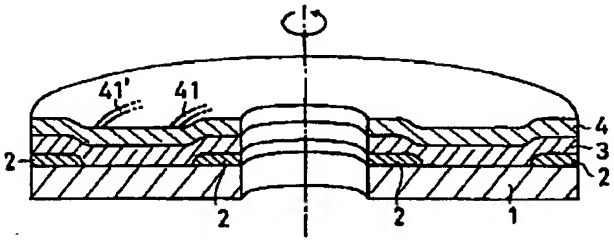

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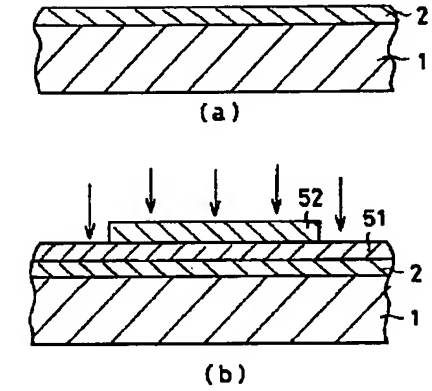

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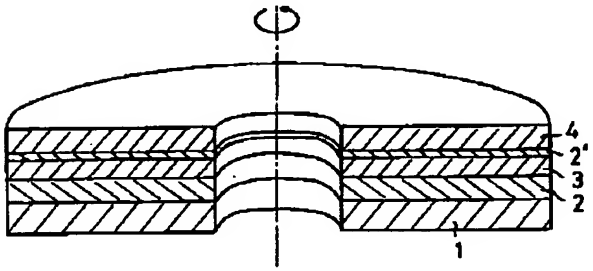

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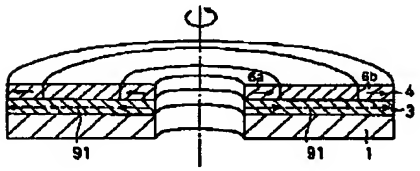

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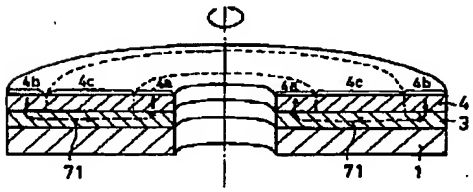

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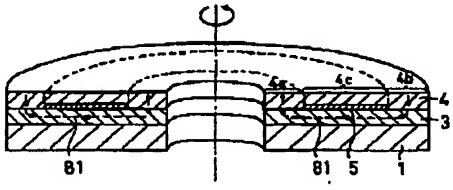
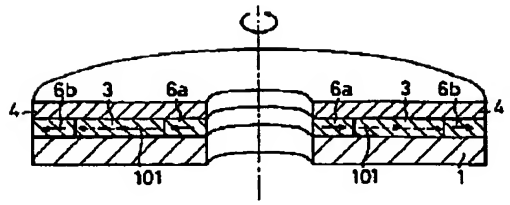
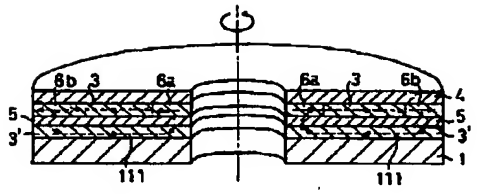


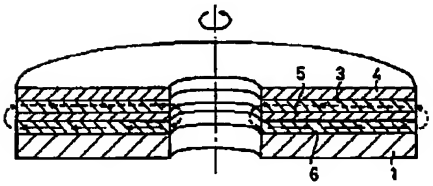
【図１０】



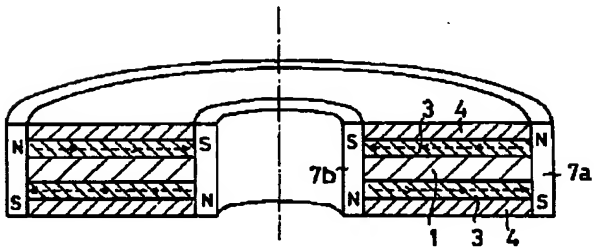
【図１１】



【図１２】



【図１３】



JP6028652

Publication Title:

PERPENDICULAR MAGNETIC RECORDING MEDIUM

Abstract:

PURPOSE:To suppress Barkhausen noises by forming a bias magnetic field-imparting film to the surface on the substrate side of a high-permeability magnetic film.

CONSTITUTION:The bias magnetic field-imparting film 2 is formed on a substrate 1 and the high-permeability magnetic film 3 is formed thereon. Further, a perpendicularly magnetized film 4 for recording signal magnetization is formed thereon. An exchange interaction acts on the boundary between the bias film 2 and the high-permeability magnetic film 3 and the bias magnetic field is impressed to the magnetic film 3. As a result, the generation of the magnetic walls in the magnetic film 3 is suppressed and the Barkhausen noises are suppressed. A spacing layer, such as antiferromagnetic film, is not formed between the perpendicularly magnetized film 4 and the magnetic film 3 and therefore, the action of the thickness of the antiferromagnetic film as a spacing loss at the time of recording and reproducing does not arise. Consequently, the perpendicular magnetic recording medium having high recording and reproducing efficiency and high resolving power is obtd.

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : TOSHIBA CORP
(72)Inventor : AKIYAMA JUNICHI

(54) PERPENDICULAR MAGNETIC RECORDING MEDIUM

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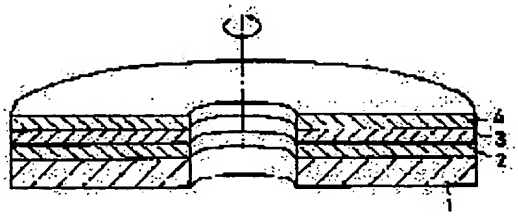

LEGAL STATUS

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[Date of sending the examiner's decision of rejection]	29.05.2001
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The vertical-magnetic-recording medium characterized by forming the bias field grant film in the field by the side of the substrate of said high permeability magnetic film at least in the vertical-magnetic-recording medium which consists of a substrate, a high permeability magnetic film formed on this substrate, and perpendicular magnetic anisotropy films which record the signal magnetization formed on this high permeability magnetic film.
[Claim 2] The vertical-magnetic-recording medium according to claim 1 characterized by coming to form a nonmagnetic membrane between said bias field grant film and said high permeability magnetic film.
[Claim 3] Said bias field grant film is a vertical-magnetic-recording medium according to claim 1 or 2 characterized by being the antiferromagnetism film.
[Claim 4] Said bias field grant film is a vertical-magnetic-recording medium according to claim 1 or 2 characterized by being the high coercive force magnetic film which has a stacking tendency within a field.
[Claim 5] Said bias field grant film is a vertical-magnetic-recording medium according to claim 1 or 2 which is the cascade screen which a magnetic film and a nonmagnetic membrane turn into from said at least two magnetic films by which the laminating was carried out by turns, and is characterized by said magnetic film by which the laminating was carried out through said nonmagnetic membrane, and which carries out phase opposite coming to join together in antiferromagnetism.
[Claim 6] The vertical-magnetic-recording medium which is a vertical-magnetic-recording medium which consists of a substrate, a high permeability magnetic film formed on this substrate, and perpendicular magnetic anisotropy films which record the signal magnetization formed on this high permeability magnetic film, and is characterized by carrying out perpendicular magnetization in the direction which faces the predetermined field of the both ends of the record playback field in said perpendicular magnetic anisotropy films.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the magnetic-recording medium of the vertical magnetic recording used for a magnetic disk, VTR, etc.
[0002]
[Description of the Prior Art] There is a record medium of the two-layer structure which formed the perpendicular magnetic anisotropy films which use a medium side perpendicular direction as an easy axis in the side which is separated from a substrate, and formed the high permeability magnetic film in it from the substrate at the near side as a vertical-magnetic-recording medium used for vertical magnetic recording (JP,52-78403,A), and it is known that this two-layer structure vertical-magnetic-recording medium shows the record reproducing characteristics in which perpendicular magnetic anisotropy films excelled the record medium of a monolayer.
[0003] However, in the above-mentioned conventional two-layer structure vertical-magnetic-recording medium, the noise of the letter of a spike is observed at the time of record playback. It is not generated by the interaction with the perpendicular magnetic anisotropy films by which not being observed is checked in case a record playback experiment is conducted using the record medium of the monolayer structure which consists only of perpendicular magnetic anisotropy films, therefore the laminating was carried out to the high permeability magnetic film on it, and this letter noise of a spike is produced only from a high permeability magnetic film. Moreover, a magnetic domain wall is not generated in the field which this letter noise of a spike has the field which does not generate uniformly and is generated in a medium, and the field which is not generated, the magnetic domain wall has generated in the field which the letter noise of a spike generates, and the letter noise of a spike does not generate. [many] This letter noise of a spike originates in a magnetic domain wall carrying out irreversible transition, and, generally is called the Barkhausen noise.
[0004] The above thing shows that what is necessary is just to control generating of the magnetic domain wall in a high permeability magnetic film, in order to control generating of a Barkhausen noise. As what controls generating of this Barkhausen noise effectively, by using the switched connection produced in the interface of a ferromagnetic and the antiferromagnetic substance, the antiferromagnetism film impresses the bias field to a high permeability magnetic film, consequently the method of controlling generating of the magnetic domain wall in a high permeability magnetic film is learned (JP,3-53686,B). The structure of this vertical-magnetic-recording medium forms a high permeability magnetic film first on a substrate, forms the antiferromagnetism film on this high permeability magnetic film, and forms perpendicular magnetic anisotropy films on this antiferromagnetism film further. Thus, it is shown that surely a Barkhausen noise is controlled at the time of record playback of the formed vertical-magnetic-recording medium.
[0005] in order that [however,] this above-mentioned structure may form the antiferromagnetism film between perpendicular magnetic anisotropy films and a high permeability magnetic film -- the thickness of the antiferromagnetism film -- the time of record playback -- as spacing loss -- working -- consequently, record regeneration efficiency and record -- bringing about the fall of resolving power, the Barkhausen noise had the problem that the sensibility and resolving power at the time of record playback of what can be controlled were not enough.
[0006]
[Problem(s) to be Solved by the Invention] In the time of the record playback in the vertical-magnetic-recording medium which carried out sequential formation of a high permeability magnetic film, a high permeability magnetic film, the antiferromagnetism film, the antiferromagnetism film, and the perpendicular magnetic anisotropy films on the

substrate like **** While a Barkhausen noise is controlled, in order to form the antiferromagnetism film between perpendicular magnetic anisotropy films and a high permeability magnetic film, the thickness of the antiferromagnetism film -- the time of record playback -- as spacing loss -- working -- consequently, record regeneration efficiency and record -- bringing about the fall of resolving power, the Barkhausen noise had the problem that the sensibility and resolving power at the time of record playback of what can be controlled were not enough.
[0007] This invention offers the vertical-magnetic-recording medium which is moreover high sensitivity and enables record playback of a high resolution while being able to control a Barkhausen noise.
[0008]
[Means for Solving the Problem] This invention consists of a substrate, bias field grant film formed on this substrate, a high permeability magnetic film formed on this bias field grant film, and perpendicular magnetic anisotropy films which record the signal magnetization formed on this high permeability magnetic film, in order to solve the above-mentioned conventional technical problem.
[0009]
[Function] According to this invention, since it comes to carry out sequential formation of the bias film, a high permeability magnetic film, and the perpendicular magnetic anisotropy films on a substrate, an exchange interaction works to the interface of the bias film and a high permeability magnetic film, and a bias field is impressed to this high permeability magnetic film, consequently magnetic domain wall generating in a high permeability magnetic film is controlled, and a Barkhausen noise can be controlled.
[0010] Moreover, by carrying out sequential formation of a high permeability magnetic film and the perpendicular magnetic anisotropy films on a substrate, and carrying out the perpendicular magnetization of the field of the both ends of the truck cross direction of perpendicular magnetic anisotropy films to hard flow mutually If it makes it hard for this field to fix the magnetization in the high permeability magnetic film corresponding to the field by which was magnetically combined with the high permeability magnetic film, and perpendicular magnetization was carried out crosswise [of a magnetic disk / truck] (disk radial), and to move it In the high permeability magnetic film corresponding to the location of record playback field 4c between the perpendicular magnetization fields in perpendicular magnetic anisotropy films While a bias field can be impressed crosswise [truck], being able to control generating of the magnetic domain wall in the high permeability magnetic film 3 and being able to control generating of a Barkhausen noise Since the permeability of the truck longitudinal direction (disk circumferencial direction) in the field of the high permeability magnetic film corresponding to the location of the record playback field of perpendicular magnetic anisotropy films hardly falls, it does not cause decline in record regeneration efficiency.
[0011] Furthermore, since a spacing layer does not exist between perpendicular magnetic anisotropy films and a high permeability magnetic film, there is no spacing loss at the time of record playback, it is high record regeneration efficiency, and a high resolution can be obtained.
[0012]
[Example] Hereafter, one example of this invention is explained, referring to a drawing.
[0013] Drawing 1 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 1st example of this invention. The high permeability magnetic film 3 with which the bias field grant film 2 which consists of antiferromagnetism film, such as FeMn and NiO, is formed, and consists of a permalloy, Fe radical soft magnetism film, or amorphous soft magnetism film of Zr system on this bias field grant film 2 is formed on the substrate 1 with which this vertical-magnetic-recording medium consists of circular ring tabular disks, such as aluminum and glass. Furthermore, it has come to form the perpendicular magnetic anisotropy films 4 which consist of CoCr on which signal magnetization is recorded, CoPt, etc. on the high permeability magnetic film 3.
[0014] The bias field grant film 2 may be high coercive force magnetic films, such as CoPt, CoPtCr, and CoCr, instead of the antiferromagnetism film. Moreover, the bias field grant film 2 may be artificial grid film which the magnetic films 21 and 21 with which the laminating of a magnetic film 21 and the nonmagnetic membrane 22 was carried out by turns, and the laminating was carried out through the nonmagnetic membrane 22, and which carry out phase opposite combined in antiferromagnetism, as shown in drawing 2 . n which this artificial grid film becomes from n layers (CoFe/Cu), n (Co/Cu), and n (Fe/Cr) etc. -- it is mentioned.
[0015] Since switched connection of the bias field grant film 2 and the high permeability magnetic film 3 is carried out in the interface and a bias field is impressed to the high permeability magnetic film 3 by making it the above configurations, generating of the magnetic domain wall within the high permeability magnetic film 3 is controlled, and

generating of the Barkhausen noise on a spike can be controlled. Moreover, since it is directly formed on the high permeability magnetic film 3, perpendicular magnetic anisotropy films 4 do not have the spacing loss at the time of record playback, and it is a high resolution and they become possible [acquiring high record regeneration efficiency].
[0016] In addition, if induced magnetic anisotropy is given adding a field crosswise [of a magnetic-recording medium / recording track] in case the bias field grant film 2 and the high permeability magnetic film 3 in this example are formed by a spatter etc., a bias field can be effectively impressed to the high permeability magnetic film 3.
[0017] Drawing 3 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 2nd example of this invention. In drawing 3 , the nonmagnetic membrane 5 is formed between the bias field grant film 2 and the high permeability magnetic films 3 which were formed on the substrate 1. Since the reinforcement of the switched connection in an interface with the high permeability magnetic film 3 changes with classes of bias field grant film 2, the reinforcement of the bias field which joins the high permeability magnetic film 3 will also differ. Therefore, since the bias field beyond the need will be added to the high permeability magnetic film 3 if switched connection is too strong, the permeability mu of the high permeability magnetic film 3 will decrease, and degradation of record regeneration efficiency will be caused. Then, by forming a nonmagnetic membrane 5 between the bias field grant film 2 and the high permeability magnetic film 3, the reinforcement of switched connection can be adjusted, and it becomes possible to control a Barkhausen noise, maintaining the optimal record playback sensibility. This nonmagnetic membrane 5 should just choose that class and thickness according to terms and conditions, such as the magnetic properties of the bias field grant film 2 and the high permeability magnetic film 3, and thickness.
[0018] Drawing 4 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 3rd example of this invention. In drawing 4 , the bias field grant film 2 is annularly formed in the predetermined location where the outside of the record playback field between the most inner tracks 41 and outermost periphery truck 41' in a circular ring tabular magnetic disk corresponds. This vertical-magnetic-recording medium is manufactured by the approach shown below. That is, first, as shown in drawing 5 (a), the bias field grant film is formed by vacuum evaporationo, a spatter, etc. on a substrate 1. Next, a resist 51 is applied on the bias field grant film 2, and after carrying out the mask of the record playback field of a magnetic-recording medium, and the field (for example, field which includes an outermost periphery truck from the most inner track of a magnetic disk) which should become with a mask 52, it is made to expose, as shown in drawing 5 (b). Next, after removing a resist 51 as are shown in drawing 5 (c), and the field which was not exposed with a mask 52 is removed by etching etc. and shown in drawing 5 (d), the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4 are formed by vacuum evaporationo, a spatter, etc.
[0019] Therefore, in order for a bias field to join the bias field grant film 2 only at the part of the high permeability magnetic film 3 which carries out phase opposite with the above configurations, generating of the magnetic domain wall of this part is controlled. And control of magnetic domain wall generating of this part controls generating of a magnetic domain wall effectively as a result to the field in which the bias field is not formed. Therefore, the Barkhausen noise by magnetic domain wall generating can be controlled.
[0020] In addition, since record playback of signal magnetization is not performed in the perpendicular magnetic anisotropy films 4 corresponding to the field and the field of the high permeability magnetic film 3 on the bias field grant film 2 does not need to take permeability mu into consideration, it may strengthen switched connection reinforcement of the bias field grant film 2 and the high permeability magnetic film 3. Moreover, in this example, since there is no decline in the permeability mu in a record playback field, a magnetic interaction with the magnetic head can be strengthened and it becomes possible to realize high sensitivity and record playback of a high resolution further.
[0021] Furthermore, you may make it the vertical-magnetic-recording medium concerning this invention prepare antiferromagnetism film 2' also between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, as shown in drawing 6 . In this case, antiferromagnetism film 2' is thinly formed in extent on which spacing loss is not made to act.
[0022] Drawing 7 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 4th example of this invention. As for the vertical-magnetic-recording medium concerning this example, the high permeability magnetic film 2 and perpendicular magnetic anisotropy films 3 are formed in order on the substrate 1. Moreover, the perpendicular magnetization fields 4a and 4b of predetermined width of face are formed in the inner circumference [of the perpendicular magnetic anisotropy films 4 in a circular ring tabular magnetic disk], and periphery side. The perpendicular magnetization of the perpendicular magnetization field 4b by the side of a

periphery is carried out in the direction of a substrate from the field which counters a head in the direction of a field in which these perpendicular magnetization fields 4a and 4b counter hard flow, and perpendicular magnetization field 4a for example, by the side of inner circumference counters a head from a substrate mutually.
[0023] Therefore, by combining magnetically these perpendicular magnetization fields 4a and 4b and the high permeability magnetic film 3 (any of the switched connection or magnetostatic association by the exchange interaction being sufficient) If it is made hard to fix the magnetization in the high permeability magnetic film 3 corresponding to the perpendicular magnetization fields 4a and 4b crosswise [of a magnetic disk / truck] (disk radial), and to move In the high permeability magnetic film 3 corresponding to the location of record playback field 4c between the perpendicular magnetization fields 4a and 4b in perpendicular magnetic anisotropy films 4 Since the bias field shown with a broken line 71 is impressed and generating of the magnetic domain wall in the high permeability magnetic film 3 can be controlled, generating of a Barkhausen noise can be controlled. Moreover, since the permeability of the truck longitudinal direction (disk circumferencial direction) in the field of the high permeability magnetic film 3 corresponding to the location of record playback field 4c of perpendicular magnetic anisotropy films 4 hardly falls, it does not cause decline in record regeneration efficiency. Furthermore, since spacing layers, such as antiferromagnetism film, are not formed between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, it is high record regeneration efficiency, and the vertical-magnetic-recording medium of a high resolution can be realized.
[0024] The modification of others of the vertical-magnetic-recording medium applied to this invention at drawing 8 thru/or drawing 13 is shown. The vertical-magnetic-recording medium in drawing 8 forms a nonmagnetic membrane 5 between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4. That is, in the interface of the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, the nonmagnetic membrane 5 which is extent which can cut off the switched connection in the interface is formed in the location corresponding to record playback field 4c of perpendicular magnetic anisotropy films 4.
[0025] Therefore, since it is combinable in magnetostatic in the interface corresponding to record playback field 4c of the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, also when the high permeability magnetic film 3 is made thin if needed, the high permeability magnetic film 3 can realize good record playback, without falling by signal magnetization.
[0026] As for the vertical-magnetic-recording medium in drawing 9 , the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4 are formed on the substrate 1. And since the high coercive force magnetic films 6a and 6b which have a stacking tendency are formed in the longitudinal direction magnetized crosswise [truck] by predetermined width of face at the inner circumference [of the perpendicular magnetic anisotropy films 4 in a circular ring tabular magnetic disk], and periphery side, the high permeability magnetic film 3 and the high coercive force magnetic films 6a and 6b can be combined magnetically, and the same effectiveness can obtain.
[0027] The high coercive force magnetic films 6a and 6b with which the vertical-magnetic-recording medium in drawing 10 has a stacking tendency in the longitudinal direction magnetized crosswise [truck] at the inner circumference [on a substrate 1] and periphery side are formed, and the high permeability magnetic film 3 is formed in the location corresponding to the record playback field between these high coercive force magnetic films 6a and 6b. Furthermore, on this high permeability 3 and high coercive force magnetic film 6a, and 6b, the perpendicular magnetic anisotropy films 4 by which record playback of the signal magnetization is carried out are formed. Also in this case, by magnetization of the same direction of the high coercive force magnetic films 6a and 6b, a bias field can be impressed to the high permeability magnetic film 3 in the direction of a broken line 101, and the same effectiveness can be acquired.
[0028] Sequential formation of the high coercive force magnetic films 6a and 6b and the 1st high permeability magnetic film 3 is carried out, and, as for the vertical-magnetic-recording medium in drawing 11 , it has come to form perpendicular magnetic anisotropy films 4 on a substrate 1 at a 2nd high permeability magnetic film 3', and nonmagnetic membrane 5 and this nonmagnetic membrane 5 top further on these quantities coercive force magnetic films 6a and 6b and the 1st high permeability magnetic film 3. Therefore, when magnetostatic association of the high coercive force magnetic films 6a and 6b and high permeability magnetic film 3' is carried out, the small closed magnetic circuit (broken line 111) of the magnetic-circuit resistance which has the path of quantity coercive force magnetic film 6a-> quantity permeability magnetic film 3 -> quantity coercive force magnetic film 6b-> quantity permeability magnetic film 3' (or the reverse) can be constituted, and a bias field stronger [than the vertical-magnetic-recording medium shown in drawing 9] and effective can be impressed.

[0029] As for the vertical-magnetic-recording medium in drawing 12 , it has come to carry out sequential formation of the high coercive force magnetic film 6, a nonmagnetic membrane 5, the high magnetic permeability force magnetic film 3, and the perpendicular magnetic anisotropy films 4 on a substrate 1. And since it is combined in [the high coercive force magnetic film 6 and the high permeability magnetic film 3] magnetostatic, a bias field will be impressed to the high permeability magnetic film 3 crosswise [truck].
[0030] The permanent magnets 7a and 7b with which sequential formation of the high permeability magnetic film 3 and the perpendicular magnetic anisotropy films 4 was carried out on the substrate 1, and the vertical-magnetic-recording medium of each other in drawing 13 was magnetized by the location of the both ends of a record playback field to the medium side perpendicular direction of an opposite direction are formed. Therefore, the bias field of the truck cross direction can be impressed in the high permeability magnetic film 3 like an above-mentioned example. In addition, the high coercive force magnetic films 6a and 6b may be used instead of permanent magnets 7a and 7b.
[0031] In addition, in this invention, although the perpendicular magnetic anisotropy films which signal magnetization should make each record only on one [, such as a magnetic disk,] disc-like field were formed, it may not adhere to this and you may form also in the field of another side. Moreover, although all showed the example of disc-like vertical-magnetic-recording media, such as a magnetic disk, it is also applicable to the vertical-magnetic-recording medium of the shape of a tape, such as a magnetic tape.
[0032]
[Effect of the Invention] As above, according to this invention, generating of the magnetic domain wall in a high permeability magnetic film can be controlled, and the Barkhausen noise produced in the interface of a high permeability magnetic film and perpendicular magnetic anisotropy films can be controlled effectively. Moreover, since spacing layers, such as antiferromagnetism film, are not formed between perpendicular magnetic anisotropy films and a high permeability magnetic film, the thickness of the antiferromagnetism film does not work as spacing loss at the time of record playback, it is high record regeneration efficiency as the result, and the vertical-magnetic-recording medium of a high resolution can be realized.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001] [Industrial Application] This invention relates to the magnetic-recording medium of the vertical magnetic recording used for a magnetic disk, VTR, etc.

[0002] [Description of the Prior Art] There is a record medium of the two-layer structure which formed the perpendicular magnetic anisotropy films which use a medium side perpendicular direction as an easy axis in the side which is separated from a substrate, and formed the high permeability magnetic film in it from the substrate at the near side as a vertical-magnetic-recording medium used for vertical magnetic recording (JP,52-78403,A), and it is known that this two-layer structure vertical-magnetic-recording medium shows the record reproducing characteristics in which perpendicular magnetic anisotropy films excelled the record medium of a monolayer.

[0003] However, in the above-mentioned conventional two-layer structure vertical-magnetic-recording medium, the noise of the letter of a spike is observed at the time of record playback. It is not generated by the interaction with the perpendicular magnetic anisotropy films by which not being observed is checked in case a record playback experiment is conducted using the record medium of the monolayer structure which consists only of perpendicular magnetic anisotropy films, therefore the laminating was carried out to the high permeability magnetic film on it, and this letter noise of a spike is produced only from a high permeability magnetic film. Moreover, a magnetic domain wall is not generated in the field which this letter noise of a spike has the field which does not generate uniformly and is generated in a medium, and the field which is not generated, the magnetic domain wall has generated in the field which the letter noise of a spike generates, and the letter noise of a spike does not generate. [many] This letter noise of a spike originates in a magnetic domain wall carrying out irreversible transition, and, generally is called the Barkhausen noise.

[0004] The above thing shows that what is necessary is just to control generating of the magnetic domain wall in a high permeability magnetic film, in order to control generating of a Barkhausen noise. As what controls generating of this Barkhausen noise effectively, by using the switched connection produced in the interface of a ferromagnetic and the antiferromagnetic substance, the antiferromagnetism film impresses the bias field to a high permeability magnetic film, consequently the method of controlling generating of the magnetic domain wall in a high permeability magnetic film is learned (JP,3-53686,B). The structure of this vertical-magnetic-recording medium forms a high permeability magnetic film first on a substrate, forms the

antiferromagnetism film on this high permeability magnetic film, and forms perpendicular magnetic anisotropy films on this antiferromagnetism film further. Thus, it is shown that surely a Barkhausen noise is controlled at the time of record playback of the formed vertical-magnetic-recording medium.

[0005] in order that [however,] this above-mentioned structure may form the antiferromagnetism film between perpendicular magnetic anisotropy films and a high permeability magnetic film -- the thickness of the antiferromagnetism film -- the time of record playback -- as spacing loss -- working -- consequently, record regeneration efficiency and record -- bringing about the fall of resolving power, the Barkhausen noise had the problem that the sensibility and resolving power at the time of record playback of what can be controlled were not enough.

[0006] [Problem(s) to be Solved by the Invention] In the time of the record playback in the vertical-magnetic-recording medium which carried out sequential formation of a high permeability magnetic film, a high permeability magnetic film, the antiferromagnetism film, the antiferromagnetism film, and the perpendicular magnetic anisotropy films on the substrate like **** While a Barkhausen noise is controlled, in order to form the antiferromagnetism film between perpendicular magnetic anisotropy films and a high permeability magnetic film, the thickness of the antiferromagnetism film -- the time of record playback -- as spacing loss -- working -- consequently, record regeneration efficiency and record -- bringing about the fall of resolving power, the Barkhausen noise had the problem that the sensibility and resolving power at the time of record playback of what can be controlled were not enough.

[0007] This invention offers the vertical-magnetic-recording medium which is moreover high sensitivity and enables record playback of a high resolution while being able to control a Barkhausen noise.

[0008] [Means for Solving the Problem] This invention consists of a substrate, bias field grant film formed on this substrate, a high permeability magnetic film formed on this bias field grant film, and perpendicular magnetic anisotropy films which record the signal magnetization formed on this high permeability magnetic film, in order to solve the above-mentioned conventional technical problem.

[0009] [Function] According to this invention, since it comes to carry out sequential formation of the bias film, a high permeability magnetic film, and the perpendicular magnetic anisotropy films on a substrate, an exchange interaction works to the interface of the bias film and a high permeability magnetic film, and a bias field is impressed to this high permeability magnetic film, consequently magnetic domain wall generating in a high permeability magnetic film is controlled, and a Barkhausen noise can be controlled.

[0010] Moreover, by carrying out sequential formation of a high permeability magnetic film and the perpendicular magnetic anisotropy films on a substrate, and carrying out the perpendicular magnetization of the field of the both ends of the truck cross direction of perpendicular magnetic anisotropy films to hard flow mutually If it makes it hard for this field to fix the magnetization in the high permeability magnetic film corresponding to the field by which was magnetically

combined with the high permeability magnetic film, and perpendicular magnetization was carried out crosswise [of a magnetic disk / truck] (disk radial), and to move it In the high permeability magnetic film corresponding to the location of record playback field 4c between the perpendicular magnetization fields in perpendicular magnetic anisotropy films While a bias field can be impressed crosswise [truck], being able to control generating of the magnetic domain wall in the high permeability magnetic film 3 and being able to control generating of a Barkhausen noise Since the permeability of the truck longitudinal direction (disk circumferencial direction) in the field of the high permeability magnetic film corresponding to the location of the record playback field of perpendicular magnetic anisotropy films hardly falls, it does not cause decline in record regeneration efficiency.

[0011] Furthermore, since a spacing layer does not exist between perpendicular magnetic anisotropy films and a high permeability magnetic film, there is no spacing loss at the time of record playback, it is high record regeneration efficiency, and a high resolution can be obtained.

[0012] [Example] Hereafter, one example of this invention is explained, referring to a drawing.

[0013] Drawing 1 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 1st example of this invention. The high permeability magnetic film 3 with which the bias field grant film 2 which consists of antiferromagnetism film, such as FeMn and NiO, is formed, and consists of a permalloy, Fe radical soft magnetism film, or amorphous soft magnetism film of Zr system on this bias field grant film 2 is formed on the substrate 1 with which this vertical-magnetic-recording medium consists of circular ring tabular disks, such as aluminum and glass. Furthermore, it has come to form the perpendicular magnetic anisotropy films 4 which consist of CoCr on which signal magnetization is recorded, CoPt, etc. on the high permeability magnetic film 3.

[0014] The bias field grant film 2 may be high coercive force magnetic films, such as CoPt, CoPtCr, and CoCr, instead of the antiferromagnetism film. Moreover, the bias field grant film 2 may be artificial grid film which the magnetic films 21 and 21 with which the laminating of a magnetic film 21 and the nonmagnetic membrane 22 was carried out by turns, and the laminating was carried out through the nonmagnetic membrane 22, and which carry out phase opposite combined in antiferromagnetism, as shown in drawing 2 . n which this artificial grid film becomes from n layers (CoFe/Cu), n (Co/Cu), and n (Fe/Cr) etc. -- it is mentioned.

[0015] Since switched connection of the bias field grant film 2 and the high permeability magnetic film 3 is carried out in the interface and a bias field is impressed to the high permeability magnetic film 3 by making it the above configurations, generating of the magnetic domain wall within the high permeability magnetic film 3 is controlled, and generating of the Barkhausen noise on a spike can be controlled. Moreover, since it is directly formed on the high permeability magnetic film 3, perpendicular magnetic anisotropy films 4 do not have the spacing loss at the time of record playback, and it is a high resolution and they become possible [acquiring high record regeneration efficiency].

[0016] In addition, if induced magnetic anisotropy is given adding a field crosswise [of a magnetic-recording medium / recording track] in case the bias field grant film 2 and the high

permeability magnetic film 3 in this example are formed by a spatter etc., a bias field can be effectively impressed to the high permeability magnetic film 3.

[0017] Drawing 3 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 2nd example of this invention. In drawing 3 , the nonmagnetic membrane 5 is formed between the bias field grant film 2 and the high permeability magnetic films 3 which were formed on the substrate 1. Since the reinforcement of the switched connection in an interface with the high permeability magnetic film 3 changes with classes of bias field grant film 2, the reinforcement of the bias field which joins the high permeability magnetic film 3 will also differ. Therefore, since the bias field beyond the need will be added to the high permeability magnetic film 3 if switched connection is too strong, the permeability mu of the high permeability magnetic film 3 will decrease, and degradation of record regeneration efficiency will be caused. Then, by forming a nonmagnetic membrane 5 between the bias field grant film 2 and the high permeability magnetic film 3, the reinforcement of switched connection can be adjusted, and it becomes possible to control a Barkhausen noise, maintaining the optimal record playback sensibility. This nonmagnetic membrane 5 should just choose that class and thickness according to terms and conditions, such as the magnetic properties of the bias field grant film 2 and the high permeability magnetic film 3, and thickness.

[0018] Drawing 4 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 3rd example of this invention. In drawing 4 , the bias field grant film 2 is annularly formed in the predetermined location where the outside of the record playback field between the most inner tracks 41 and outermost periphery truck 41' in a circular ring tabular magnetic disk corresponds. This vertical-magnetic-recording medium is manufactured by the approach shown below. That is, first, as shown in drawing 5 (a), the bias field grant film is formed by vacuum evaporationo, a spatter, etc. on a substrate 1. Next, a resist 51 is applied on the bias field grant film 2, and after carrying out the mask of the record playback field of a magnetic-recording medium, and the field (for example, field which includes an outermost periphery truck from the most inner track of a magnetic disk) which should become with a mask 52, it is made to expose, as shown in drawing 5 (b). Next, after removing a resist 51 as are shown in drawing 5 (c), and the field which was not exposed with a mask 52 is removed by etching etc. and shown in drawing 5 (d), the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4 are formed by vacuum evaporationo, a spatter, etc.

[0019] Therefore, in order for a bias field to join the bias field grant film 2 only at the part of the high permeability magnetic film 3 which carries out phase opposite with the above configurations, generating of the magnetic domain wall of this part is controlled. And control of magnetic domain wall generating of this part controls generating of a magnetic domain wall effectively as a result to the field in which the bias field is not formed. Therefore, the Barkhausen noise by magnetic domain wall generating can be controlled.

[0020] In addition, since record playback of signal magnetization is not performed in the perpendicular magnetic anisotropy films 4 corresponding to the field and the field of the high permeability magnetic film 3 on the bias field grant film 2 does not need to take permeability mu into consideration, it may strengthen switched connection reinforcement of the bias field grant film 2 and the high permeability magnetic film 3. Moreover, in this example, since there is no

decline in the permeability mu in a record playback field, a magnetic interaction with the magnetic head can be strengthened and it becomes possible to realize high sensitivity and record playback of a high resolution further.

[0021] Furthermore, you may make it the vertical-magnetic-recording medium concerning this invention prepare antiferromagnetism film 2' also between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, as shown in drawing 6 . In this case, antiferromagnetism film 2' is thinly formed in extent on which spacing loss is not made to act.

[0022] Drawing 7 is drawing of longitudinal section showing the configuration of the vertical-magnetic-recording medium concerning the 4th example of this invention. As for the vertical-magnetic-recording medium concerning this example, the high permeability magnetic film 2 and perpendicular magnetic anisotropy films 3 are formed in order on the substrate 1. Moreover, the perpendicular magnetization fields 4a and 4b of predetermined width of face are formed in the inner circumference [of the perpendicular magnetic anisotropy films 4 in a circular ring tabular magnetic disk], and periphery side. The perpendicular magnetization of the perpendicular magnetization field 4b by the side of a periphery is carried out in the direction of a substrate from the field which counters a head in the direction of a field in which these perpendicular magnetization fields 4a and 4b counter hard flow, and perpendicular magnetization field 4a for example, by the side of inner circumference counters a head from a substrate mutually.

[0023] Therefore, by combining magnetically these perpendicular magnetization fields 4a and 4b and the high permeability magnetic film 3 (any of the switched connection or magnetostatic association by the exchange interaction being sufficient) If it is made hard to fix the magnetization in the high permeability magnetic film 3 corresponding to the perpendicular magnetization fields 4a and 4b crosswise [of a magnetic disk / truck] (disk radial), and to move In the high permeability magnetic film 3 corresponding to the location of record playback field 4c between the perpendicular magnetization fields 4a and 4b in perpendicular magnetic anisotropy films 4 Since the bias field shown with a broken line 71 is impressed and generating of the magnetic domain wall in the high permeability magnetic film 3 can be controlled, generating of a Barkhausen noise can be controlled. Moreover, since the permeability of the truck longitudinal direction (disk circumferencial direction) in the field of the high permeability magnetic film 3 corresponding to the location of record playback field 4c of perpendicular magnetic anisotropy films 4 hardly falls, it does not cause decline in record regeneration efficiency. Furthermore, since spacing layers, such as antiferromagnetism film, are not formed between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, it is high record regeneration efficiency, and the vertical-magnetic-recording medium of a high resolution can be realized.

[0024] The modification of others of the vertical-magnetic-recording medium applied to this invention at drawing 8 thru/or drawing 13 is shown. The vertical-magnetic-recording medium in drawing 8 forms a nonmagnetic membrane 5 between the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4. That is, in the interface of the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, the nonmagnetic membrane 5 which is extent which can cut off the switched connection in the interface is formed in the location corresponding to record playback field 4c of perpendicular magnetic anisotropy films 4.

[0025] Therefore, since it is combinable in magnetostatic in the interface corresponding to record playback field 4c of the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4, also when the high permeability magnetic film 3 is made thin if needed, the high permeability magnetic film 3 can realize good record playback, without falling by signal magnetization.

[0026] As for the vertical-magnetic-recording medium in drawing 9 , the high permeability magnetic film 3 and perpendicular magnetic anisotropy films 4 are formed on the substrate 1. And since the high coercive force magnetic films 6a and 6b which have a stacking tendency are formed in the longitudinal direction magnetized crosswise [truck] by predetermined width of face at the inner circumference [of the perpendicular magnetic anisotropy films 4 in a circular ring tabular magnetic disk], and periphery side, the high permeability magnetic film 3 and the high coercive force magnetic films 6a and 6b can be combined magnetically, and the same effectiveness can obtain.

[0027] The high coercive force magnetic films 6a and 6b with which the vertical-magnetic-recording medium in drawing 10 has a stacking tendency in the longitudinal direction magnetized crosswise [truck] at the inner circumference [on a substrate 1] and periphery side are formed, and the high permeability magnetic film 3 is formed in the location corresponding to the record playback field between these high coercive force magnetic films 6a and 6b. Furthermore, on this high permeability 3 and high coercive force magnetic film 6a, and 6b, the perpendicular magnetic anisotropy films 4 by which record playback of the signal magnetization is carried out are formed. Also in this case, by magnetization of the same direction of the high coercive force magnetic films 6a and 6b, a bias field can be impressed to the high permeability magnetic film 3 in the direction of a broken line 101, and the same effectiveness can be acquired.

[0028] Sequential formation of the high coercive force magnetic films 6a and 6b and the 1st high permeability magnetic film 3 is carried out, and, as for the vertical-magnetic-recording medium in drawing 11 , it has come to form perpendicular magnetic anisotropy films 4 on a substrate 1 at a 2nd high permeability magnetic film 3', and nonmagnetic membrane 5 and this nonmagnetic membrane 5 top further on these quantities coercive force magnetic films 6a and 6b and the 1st high permeability magnetic film 3. Therefore, when magnetostatic association of the high coercive force magnetic films 6a and 6b and high permeability magnetic film 3' is carried out, the small closed magnetic circuit (broken line 111) of the magnetic-circuit resistance which has the path of quantity coercive force magnetic film 6a-> quantity permeability magnetic film 3 -> quantity coercive force magnetic film 6b-> quantity permeability magnetic film 3' (or the reverse) can be constituted, and a bias field stronger [than the vertical-magnetic-recording medium shown in drawing 9] and effective can be impressed.

[0029] As for the vertical-magnetic-recording medium in drawing 12 , it has come to carry out sequential formation of the high coercive force magnetic film 6, a nonmagnetic membrane 5, the high magnetic permeability force magnetic film 3, and the perpendicular magnetic anisotropy films 4 on a substrate 1. And since it is combined in [the high coercive force magnetic film 6 and the high permeability magnetic film 3] magnetostatic, a bias field will be impressed to the high permeability magnetic film 3 crosswise [truck].

[0030] The permanent magnets 7a and 7b with which sequential formation of the high permeability magnetic film 3 and the perpendicular magnetic anisotropy films 4 was carried out on the substrate 1, and the vertical-magnetic-recording medium of each other in drawing 13 was magnetized by the location of the both ends of a record playback field to the medium side perpendicular direction of an opposite direction are formed. Therefore, the bias field of the truck cross direction can be impressed in the high permeability magnetic film 3 like an above-mentioned example. In addition, the high coercive force magnetic films 6a and 6b may be used instead of permanent magnets 7a and 7b.

[0031] In addition, in this invention, although the perpendicular magnetic anisotropy films which signal magnetization should make each record only on one [, such as a magnetic disk,] disc-like field were formed, it may not adhere to this and you may form also in the field of another side. Moreover, although all showed the example of disc-like vertical-magnetic-recording media, such as a magnetic disk, it is also applicable to the vertical-magnetic-recording medium of the shape of a tape, such as a magnetic tape.

[0032] [Effect of the Invention] As above, according to this invention, generating of the magnetic domain wall in a high permeability magnetic film can be controlled, and the Barkhausen noise produced in the interface of a high permeability magnetic film and perpendicular magnetic anisotropy films can be controlled effectively. Moreover, since spacing layers, such as antiferromagnetism film, are not formed between perpendicular magnetic anisotropy films and a high permeability magnetic film, the thickness of the antiferromagnetism film does not work as spacing loss at the time of record playback, it is high record regeneration efficiency as the result, and the vertical-magnetic-recording medium of a high resolution can be realized.

[Translation done.]